US Army Corps of Engineers

DCAF Bulletin

Design Construction Analysis Feedback

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CEMP-EC

Subject: Sampling and Field Testing Freshly Mixed Concrete

Applicability: Guidance

Reference: ASTM C-31, Making and Curing Concrete Test Specimens in the Field
ASTM C-143, Slump of Hydraulic Cement Concrete
ASTM C 172, Sampling Freshly Mixed Concrete
ASTM C-231, Air Content of Freshly Mixed Concrete by the Pressure Method

1. It is incumbent upon the Corps to insure that concrete conforms to the requirements of the contract. Quality concrete doesn't occur without active effort by QA personnel at the jobsite. The key to quality concrete is testing. There are essentially three field tests that are performed at the jobsite: (1) Making and curing concrete specimens for strength tests (cylinders & beams); (2) Slump test; (3) Air content test.

2. Obviously, it is not possible to test all concrete that is produced for any given batch, placement, or structure. Therefore, the only feasible approach is to test small portions or samples of the concrete. These samples must truly represent the entire batch from which they are taken. Sampling techniques can be highly technical and theoretical. However, these procedures are unnecessarily precise and time consuming for field testing of freshly mixed concrete. Random sampling, in which there is no predetermined sampling pattern, will generally result in a representative sample, where each portion of the whole has an equal chance to be selected. The QA Representative should be thoroughly familiar with correct sampling techniques as defined in ASTM C-172, and must insure that QC sampling for field testing is done IAW this standard.

3. The procedure for making test cylinders and beams for strength tests is detailed in ASTM C-31. A synopsis of this method is illustrated in Enclosure 1.

4. The procedure for making slump tests is detailed in ASTM C-143. A synopsis is of this method is illustrated in Enclosure 2.

5. There are three methods for determining the air content of freshly mixed concrete. However, the most predominate method used in the field is the pressure method (ASTM C 231). The other two methods are rarely used for field testing. A synopsis of this method is illustrated in Enclosure 3.

6. The QA Representative should be thoroughly knowledgeable in these methods, and should have copies of the appropriate ASTM standards available for ready reference. He/she should closely observe the procedures used by the contractor, as well as the QA laboratory, to insure that the testing is truly indicative of the concrete quality.

7. This bulletin has been coordinated with: Technical Branch, CEMP-ET; Operations and Construction Readiness Division, CECW-OC; and Engineering Division, CECW-EG. POC for this DCAF is C. J. Harris, CEMP-EC, telephone (202) 761-8801.

Encls

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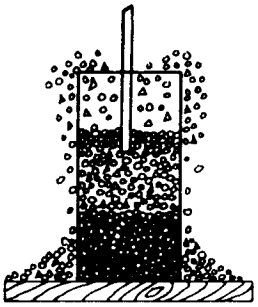
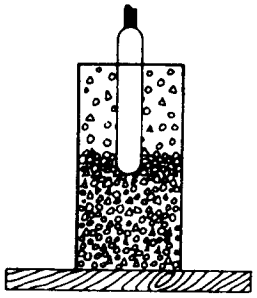
Cylinder Casting Procedure

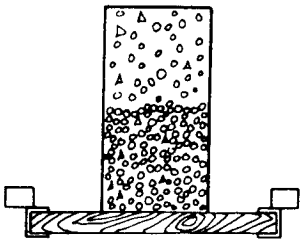
Test cylinders are prepared in the field for one of two purposes: a) To check the adequacy of the laboratory design for strength, or as a basis for acceptance. b) To determine when a structure may be put into service. These two evaluations require very different curing conditions. See ASTM Specification C 31.

1 **MOLDS** Use only non-absorptive molds. Metal or paraffined paper molds 6" in diameter by 12" in length are used for casting field specimens. While the number of cylinders to be cast for each age period of test is not specified, reliance on data from a sing cylinder test can be misleading.

2 **SAMPLE** To obtain a representative sample, take samples from two or more regular intervals throughout the discharge of the mixer truck. Combine and mix these samples for tests. DO NC take samples at the beginning or the end of discharge.







3 **CASTING** Place the cylinders on a smooth level surface in a protected area where th temperature can be maintained between 60°F and 80°F. Fill each cylinder in 2 or 3 equa layers (see below) and consolidate. The method of consolidation will be determined b the slump of the concrete. Cylinders of concrete with a slump of 3" or greater shall b rodded; slump of 1" to 3" may be rodded or vibrated and a slump of 1" or less shall b vibrated.

A. **RODDING** Fill the cylinders in 3 equal layers and rod each layer 25 times with a ⅝" diam eter by 24" long steel rod with a hemispherical end. Distribute the rodding evenly ove the entire cross section of the layer. Rodding of each consecutive layer should penetrat into but not through the preceding layer. After filling, tap the cylinders lightly to remov any voids and level the surface by striking off and trowelling. Identify each cylinder

B. **INTERNAL VIBRATION** Fill the cylinders in 2 equal layers, and consolidate with 3 pene- trations of the internal vibrator at different points for each layer. The vibrator shall have a diameter of ¾ to 1½ inches and a shaft of 21". Frequency of vibration shall be 7000 rpm or greater. DO NOT touch the sides or bottom of the mold with the vibrator. Excess vibration will cause segregation of the concrete and should be avoided. After vibrating the second layer, sufficient concrete shall be added and worked in with a trowel to level the surface.

C. **EXTERNAL VIBRATION** Attach the mold securely to the vibrating element or surface. Fill the mold in two layers. All the concrete for each layer should be placed in the mold before vibrating. The vibrating table or plank shall have a minimum frequency of 3600 rpm; preferably higher. Caution should be exercised to avoid overvibration which will cause segregation.

After casting and consolidating cover the tops of cylinders with a glass or metal plate or friction type lid to prevent loss of moisture.

4 **CURING** When cylinders are made and tested to check adequacy of the laboratory design for strength, or as the basis for accept- ance, specimens must be removed from the molds at the end of 24 hours. Storage in a moist condition (free water on the surface at all times) and at a temperature of 73.4°F ± 3.0°F must be maintained until the time of the test. A laboratory must be used to attain these curing conditions.

When transporting cylinders to the laboratory, do not permit cylinders to rattle in a box in the back of a car or in the bed of a pick-up truck. Use standard cylinder traveling case placed on a foam rubber mat.

ENCL 1 (Source: Kaiser Cement Corp.)

Slump Test Procedure

1 To obtain a representative sample, take samples from two or more regular intervals throughout the discharge of the mixer or truck. DO NOT take samples at the beginning or the end of the discharge.

2 Dampen inside of cone and place it on a smooth, moist, nor absorbent, level surface large enough to accommodate both the slumped concrete and the slump cone. Stand on foot piece throughout the test procedure to hold the cone firmly in place

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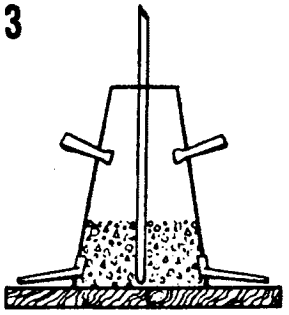

Fill cone ⅓ full **by volume** and rod 25 times with ⅝-inch-diameter x 24-inch-long hemispherical tip steel tamping rod. (This is a specification requirement which will produce non-standard results unless followed exactly.) Distribute rodding evenly over the entire cross section of the sample.

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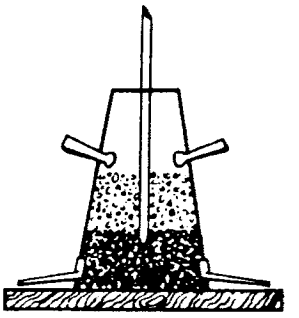

Fill cone ⅔ full **by volume.** Rod this layer 25 times with rod penetrating into, but not through, first layer. Distribute rodding evenly over the entire cross section o the layer.

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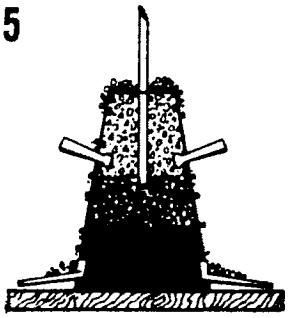

Fill cone to overflowing. Rod this layer 25 times with rod penetrating into, but not through, second layer. Distribute rodding evenly over the entire cross section of this layer.

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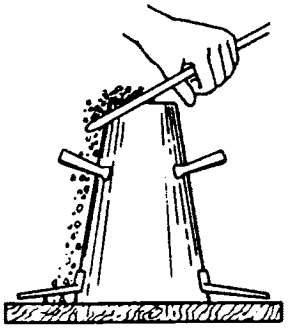

Remove the excess concrete from the top of the cone, using tamping rod as a screed. Clean overflow from base of cone.

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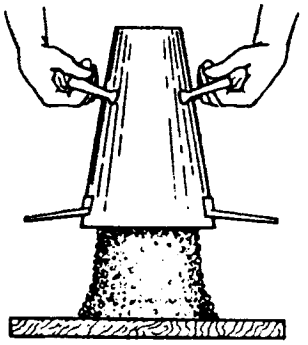

Immediately lift cone vertically with slow, even motion. Do not jar the concrete or tilt the cone during this process. Invert the withdrawn cone, and place next to, but not touching the slumped concrete. (Perform in 3–7 seconds with no lateral or torsional motion.)

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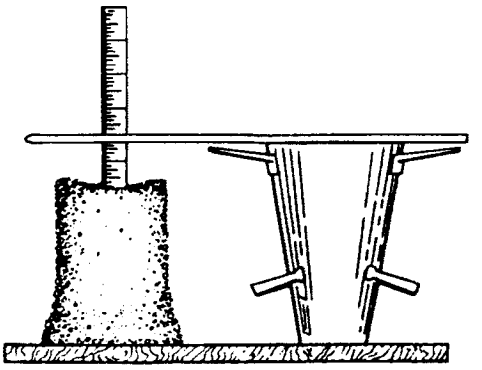


Lay a straight edge across the top of the slump cone. Measure the amount of slump in inches from the bottom of the straight edge to the top of the slumped concrete at a point over the original center of the base. The slump operation shall be completed in a maximum elapsed time of 2½ minutes. Discard concrete, DO NOT use in any other tests.

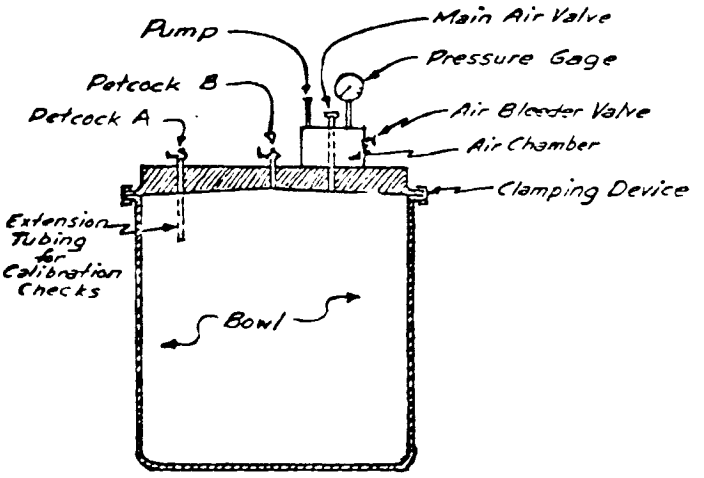
ENCL 2 (Source: Kaiser Cement Corp.)

PRESSURE METHOD FOR AIR CONTENT TESTING (ASTM C 231)

There are two types of meters A and B used to determine the air content by the pressure method. However because of the configuration of the type B meter it is usually used for field testing. This type meter operates on the principle of equalizing a known volume of air at a known pressure in a sealed chamber to obtain the value of the unknown volume of air in the concrete sample.

The general requirements of air content testing using the air pressure are:

1. Calibrate the air meter in accordance with manufacturer's instructions. Also, see Annex, ASTM C 231.
2. Fill the bowl with fresh concrete in three equal layers, rodding each layer 25 times, and tap the bowl with a mallet 10 to 15 times after each layer has been rodded. Also, sample may be consolidated using the vibration methods in enclosure 1.
3. Remove excess concrete with a sawing motion of the strike-off bar and assemble the meter.
4. Add the necessary water and pressurize.
5. Read the result from a gage and use the aggregate correction factor to obtain the true air reading. ASTM C 231 gives a procedure for determining the aggregate correction factor.



TYPE B METER

ENCL 3 (Source: ACI.)